

Five-Year Review Report

for the

**Sangamo Weston/Twelve Mile Creek/Lake Hartwell
PCB Contamination Superfund Site - Operable Unit Two
Pickens, Pickens County, South Carolina**

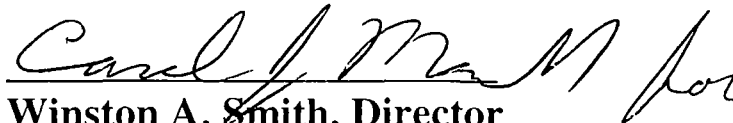
September 2004

Prepared By:



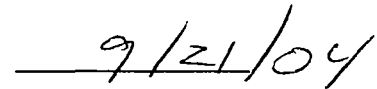
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Executive Summary

The Region 4 Office of the United States Environmental Protection Agency (EPA) issued a Record of Decision (ROD) for the Sangamo Weston/Twelve Mile Creek/Lake Hartwell PCB Contamination Superfund Site - Operable Unit Two (e.g. Sangamo OU2) in Pickens County, South Carolina in June 1994. Sangamo OU2 is the final action of two Operable Units (OUs) for this Site. OU1 addressed the land-based source areas which included the Sangamo Weston Plant and six satellite disposal areas. OU2 addresses the sediment, surface water, and biological migration pathways downstream from the source areas. The June 1994 ROD selected Monitored Natural Recovery (MNR) of PCB impacted surficial sediments in approximately 730 acres of the Twelve Mile Creek (12MC) Arm of Lake Hartwell. The major components of the OU2 remedy include:

- Continuation of the existing fish consumption advisory on Lake Hartwell,
- Implementation of a public education program to increase the awareness of the advisory and methods to prepare/cook fish to reduce the quantity of contaminants consumed,
- Continued monitoring of aquatic biota and sediment to support continuance and/or justify modifications to the existing advisory, and
- Regular flushing of sediments trapped behind three impoundments on Twelve Mile Creek to facilitate burial of contaminated sediments further downstream while mitigating adverse impacts to Lake Hartwell water quality

The fish consumption advisory on Lake Hartwell was last modified in 1998 by issuing a joint advisory between Georgia and South Carolina. The current advisory adopts a risk-based approach that issues meal advice to Lake Hartwell anglers based on species harvested and PCB concentration trends in fish tissue. Results of the public education program indicate that users of Lake Hartwell are aware of the current fish advisories, and an overwhelming majority of respondents who received public education material reported that it helped them make informed decisions about catching and consuming fish from the lake.

A health consultation was conducted by the South Carolina Department of Health and Environmental Control (SCDHEC) under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), to determine whether people eating fish from Lake Hartwell are being exposed to PCBs. This two phased effort included distribution of surveys to identify potentially exposed individuals, and blood sampling on a sub-set of individuals for serum PCB levels. SCDHEC and ATSDR concluded that blood levels for participants in the blood testing were comparable to the general U.S. population. It is important to note that heavy fish consumers were not tested during this study, but human health risks are considered minimal for people that eat small to moderate amounts of fish.

The annual aquatic biota and sediment monitoring program has been implemented annually in the Spring of each year since 1994. Three phases of additional investigations were conducted by EPA's National Risk Management Research Laboratory (NRMRL) and National

Exposure Research Laboratory (NERL) to gain a better understanding of natural mechanisms that contribute to the recovery of PCB contaminated sediments. Data from these investigations indicate that surficial sediment PCB concentrations in the 12MC Arm of Lake Hartwell have decreased steadily due to physical processes such as burial, mixing/dispersion, and PCB dechlorination. Sediment age dating indicates that the majority of surficial sediments in the 12MC Arm of Lake Hartwell will reach the 1 mg/kg cleanup goal between 2007 and 2011. However, largemouth bass, channel catfish, and hybrid bass PCB concentrations have not responded measurably to the decreased surface sediment trends. PCB concentrations in largemouth bass in the 12MC and Seneca River Arms of Lake Hartwell continue to be above the 2.0 mg/kg FDA limit, although channel catfish from these stations dropped below the 2.0 mg/kg limit in 1999 and have remained below that level. PCB concentrations in hybrid bass remain greater than 2.0 mg/kg at all six stations in Lake Hartwell.

After several iterations of evaluating effective sediment management plans for the three 12MC impoundments, EPA proposed installing high-flow sluice gates on the downstream side of the Woodside 1 (WS1) and Woodside 2 (WS2) impoundments to facilitate downstream transport of sediments to the 12MC Arm of Lake Hartwell. However, the Natural Resource Trustees (NRTs) and Schlumberger (responsible party) have reached a technical agreement in principle that would, among other items, involve removal of the WS1/WS2 dams with subsequent stream restoration for an approximate 10,000 foot reach of 12MC. EPA fully supports the dam removal concepts envisioned in the Natural Resource Damage Assessment (NRDA) settlement as it represents the most permanent solution to ensuring natural sediment transport downstream to the 12MC Arm of Lake Hartwell. The NRTs and Schlumberger are expecting to release the formal Lake Hartwell Restoration and Compensation Determination Plan during the fourth quarter of 2004.

FIVE-YEAR REVIEW SUMMARY FORM		
Site Identification		
Site Name: Sangamo Weston/Twelve Mile Creek/Lake Hartwell - Operable Unit Two		
EPA ID: SCD980310239		
Region: 04	State: South Carolina	City/County: Pickens/Pickens
Site Status		
NPL Status: Final (February 1990)		
Remediation Status: Construction Complete/Long-term monitoring for remedy effectiveness		
Multiple OUs: YES	Construction Complete Date: 08/09/99	
Has site been put into reuse: N/A (note site is primarily lake and river environment)		
Review Status		
Lead Agency: EPA		
Author: Craig Zeller, P E		
Author title: Remedial Project Manager		Author Affiliation: U S EPA - Region 4
Review Period: 10/01/03 to 08/31/04		
Date(s) of site inspection: N/A (note no actual physical construction associated with this OU)		
Type of review: Post-Sara		
Review number: First		
Triggering action: Notice of Intent to Comply with UAO		
Triggering action date (from WasteLAN): 10/19/98		
Due date: 10/19/03		
ISSUES: None		
RECOMMENDATIONS AND FOLLOW-UP ACTIONS: Maintain current fish consumption advisory Continue annual monitoring of aquatic biota and sediments with modifications recommended by EPA-NRMRL Monitor progress of Natural Resource Damage Settlement between Natural Resource Trustees (NRTs) and Schlumberger (PRP) regarding dam demolition and stream restoration along Twelve Mile Creek corridor		
PROTECTIVENESS STATEMENT(S): The MNR/Institutional Controls remedy for OU2 is considered adequately protective of human health and the environment while long-term monitoring of aquatic biota and sediments continue in the future Soil cleanup at OUI is completed, and active groundwater recovery and treatment continues at the Breazeale site and the Plant site Since operation and maintenance of these systems will be optimized to meet established performance standards, this site is considered adequately protective of human health and the environment		

I. INTRODUCTION

The purpose of five year reviews is to determine whether the remedy at a site is or is expected to be protective of human health and the environment. The methods, findings and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and recommendations to address them.

The Agency is preparing this five-year review pursuant to CERCLA Section 121 and the National Contingency Plan. CERCLA Section 121 states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with Section 104 or 106, the President shall take or require such action. The President shall report to Congress a list of facilities for which such a review is required, the results of all such reviews, and any action taken as a result of such reviews

The Agency interpreted this requirement further in the National Contingency Plan (NCP) 40 CFR Section 300.430(f)(4)(ii) states:

If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action

EPA Region 4 has conducted a Five-Year Review of the Monitored Natural Recovery (MNR) remedy for Operable Unit Two of the Sangamo Weston/Twelve Mile Creek/Lake Hartwell PCB Contamination Superfund Site (e.g. Sangamo OU2) in Pickens County, South Carolina. This review was conducted from October 2003 through August 2004. This report documents the results of the review. This is the first Five-Year Review for the site. The triggering action for this review is a 10/19/98 notice from Schlumberger, the site PRP, that they intend to comply with the Unilateral Administrative Order (UAO) for Remedial Action as shown in EPA's WasteLAN database. The Five-Year Review is considered necessary due to the presence of PCBs in sediments and aquatic biota that does not allow for unlimited use and unrestricted exposure.

II. SITE CHRONOLOGY

The following table presents the primary milestones and relevant dates in the site chronology.

EVENT	DATE
Proposed to National Priorities List	January 1987
Final to National Priorities List	February 1990
RI/FS Special Notice Letter to Schlumberger	April 1990
Fund-Lead Remedial Investigation/Feasibility Study	September 1990 - April 1994
Final Record of Decision	June 1994
Annual monitoring of aquatic biota/sediments	April/May since 1995
Trash-rack rakes installed at Woodside I/II impoundments to facilitate downstream passage of sediments	June 1994
Trash-rack rakes not performing as expected	September 1997
Initial sediment management alternative evaluation for 12 Mile Creek impoundments	September 1997 - March 1998
Public education program and issuance of a joint, risk-based fish consumption advisory by states of SC & GA	July 1998
Initial sediment dredging at Woodside I/II impoundments	October 1998
2 nd sediment dredging at Woodside I/II impoundments	July 1999
Data collection for sediment transport modeling	December 1999
High flow sluice gate installation evaluation	January 2000
Sediment transport modeling and 2 nd sediment management alternative evaluation for 12 Mile Creek impoundments completed	April 2000
Public education telephone interviews completed	July 2000
3 rd sediment dredging at Woodside I/II impoundments	January 2001
Phase 1 MNR investigation report completed by EPA-ORD	September 2001
4 th (and last to date) sediment dredging at Woodside I/II impoundments	February 2002

Final Phase 2 MNR investigation report completed by EPA-ORD	June 2002
2 nd data collection effort for sediment transport modeling	November 2002
Sediment transport modeling and morphology evaluation to evaluate in-stream impacts from dam removal	April 2003
<i>Draft</i> Phase 3 MNR investigation report completed by EPA-ORD	April 2003
Final Health Consultation regarding Lake Hartwell Fish Consumption	July 2004

III. BACKGROUND

This section of the Five-Year Review report provides a brief site background and description of the site characteristics. The reader is referred to the references listed in Section VI. of this report for a more detailed account of this subject matter.

Sangamo Weston manufactured electrolytic mica and power factor capacitors at the Pickens, SC plant from 1955 to 1978. The plant used a variety of dielectric fluids in the manufacturing processes, including fluids that contained PCBs. Waste disposal practices included land burial of off-specification capacitors and wastewater treatment sludge on the plant site and six satellite disposal areas. PCBs were discharged with effluent directly into Town Creek, a tributary of Twelvemile Creek (12MC), which is in turn a major tributary of Lake Hartwell. Lake Hartwell was created between 1955 and 1963 when Hartwell Dam was constructed by the U.S. Army Corps of Engineers on the upper Savannah River. At the normal pool level of 660 feet MSL, Lake Hartwell is 56,000 acres in size with a shoreline of 962 miles.

Between 1955 and 1977, the average quantity of PCBs received and used at the plant ranged from 700,000 to 2,000,000 lbs/yr. An estimated 3% of the quantities received and used at the plant were discharged to Town Creek, resulting in an estimated cumulative discharge of over 400,000 lbs of PCBs. An unspecified amount was buried at the six satellite disposal areas and the plant site. PCB use was terminated at the plant in 1977, prior to an EPA ban of its use in January 1978. A fish consumption advisory for Lake Hartwell was first instituted in 1976. This advisory has been modified many times, and remains in effect.

The Sangamo site was proposed to the National Priorities List (NPL) in January 1987, and became Final on the NPL in February 1990. The site was divided into two operable units (OUs). OU1 addressed the land-based source areas which included the plant site and six satellite disposal areas. OU2 addressed the sediment, surface water, and biological migration pathways downstream from the source areas. Construction completion was achieved for OU1 in August 1999. In general, the cleanup activities at OU1 involved excavation of PCB impacted material at

the Sangamo Plant and the satellite dump sites, followed by temporary staging on the plant property. Approximately 60,000 tons (e.g. 40,000 cubic yards) of PCB impacted material was treated via thermal desorption on the plant property from December 1995 through May 1997. Active groundwater recovery and treatment for PCBs and some volatile organics continue at the plant site and one satellite dump site known as the Breazeale property.

As a result of a merger with Sangamo Weston in 1989, the responsible party for the Sangamo site is Schlumberger out of Houston, TX. Schlumberger performed the Remedial Action at OU1 pursuant to the terms of a Consent Decree with EPA. EPA issued a Special Notice Letter to Schlumberger in April 1990 which offered them the opportunity to conduct an enforcement lead Remedial Investigation/Feasibility Study (RI/FS) for OU2. Schlumberger declined this offer, and EPA conducted a Fund-Lead RI/FS for OU2 from September 1990 through April 1994.

A comprehensive discussion and presentation of the RI/FS findings and conclusions can be found in the RI/FS documents and the June 1994 ROD. In general, approximately 730 acres of sediments in the 12MC Arm of Lake Hartwell had PCB concentrations greater than the selected cleanup goal of 1 mg/kg. The 12MC Arm of Lake Hartwell is generally described as the reach between the Highway 337 bridge (e.g. Maw Bridge) and the Highway 123 bridge near Clemson. Within the 12MC watershed, minor levels of PCB contamination have persisted in Town Creek near the Sangamo discharge point, and in sediments trapped behind the 3 small dams on 12MC (e.g. see discussion in Section IV below). The 12MC Arm of Lake Hartwell is considered to be a relatively low energy environment and net depositional. PCB distribution in surface sediments could be described as low-level and wide-spread, without distinct hot-spots. Average PCB concentrations in surficial sediments (e.g. 0 to 6 inches) of the focused study area were generally in the 1 to 10 mg/kg range.

Vertical sediment cores indicated PCB concentrations increased with depth, and the maximum detections generally occurred 30 cm to 50 cm below the surface water/sediment interface. Historically, the maximum PCB detection was 153 mg/kg, although the maximum detected during the RI was 61 mg/kg. RI results indicated that PCB concentrations in sediments had declined significantly from the mid-1980's due to burial and dispersion processes. These conclusions were supported by sediment transport modeling that predicted net sediment accumulations ranging from 5 to 15 cm/yr in the portions of 12MC Arm of Lake Hartwell that historically had the highest levels of PCBs.

The biological investigations conducted during the RI/FS phase confirmed that PCBs were detected in all levels of the food chain, including drift net samples, *corbicula* (e.g. fresh water clams) baskets, smaller forage fish, and migratory/non-migratory game fish. The biological investigation also supported conclusions of the sediment component that 1) the Sangamo plant site is the primary source of PCB contamination in 12MC, and 2) the contribution of PCB input to the 12MC watershed from the satellite disposal areas is negligible. Fish in Lake Hartwell were found to contain PCBs at levels often higher than the FDA safe tolerance limit of

2 mg/kg PCB concentrations in non-migratory fish (e.g. channel catfish/largemouth bass) were highest in the 12MC Arm of Lake Hartwell, and levels decreased at sample stations within Lake Hartwell proper. Migratory fish (e.g. hybrid bass) had PCB levels that are similar throughout the entire reservoir, and were generally above the 2 mg/kg level. Aquatic bioaccumulation modeling was also conducted to predict future PCB levels in fish of the 12MC/Lake Hartwell system using the FGETS model. In response to decreasing water column and surface sediment PCB concentrations, largemouth bass concentrations in the 12MC Arm of Lake Hartwell were predicted to fall below the 2 mg/kg FDA level in the 2003 to 2005 time frame.

The need for future response actions at Sangamo OU2 were largely driven by human health risks associated with the consumption of PCB-contaminated fish. The highest cancer risk of 4×10^{-2} was calculated for anglers exclusively consuming largemouth bass in the 12MC watershed. The highest cancer risk for ingestion of all species combined, 1×10^{-2} , was calculated for the 12MC Arm of Lake Hartwell. The lake-wide risk associated with ingestion of all fish species combined was 5×10^{-3} . From an ecological risk perspective, the biological investigations documented the presence of PCB contamination in all levels of the aquatic food web. Although PCBs appeared to be impacting fish and macroinvertebrate communities in 12MC, the ecological risk assessment concluded that habitat degradation from man's influence was likely causing greater adverse impacts at the population and community levels. The health of fish in Lake Hartwell did not appear to be affected at the population level for fish that have PCB concentrations around 5 mg/kg (e.g. average concentrations in fish at ROD time). However, there was historical evidence that as concentrations increased to greater than 20 mg/kg, fish health could be affected.

Pursuant to the findings and conclusions of the RI/FS, EPA issued a Proposed Plan in April 1994 for the Sangamo OU2 site. The preferred alternative incorporated a fishery isolation barrier, and a series of institutional controls that included a public education program, fish/sediment monitoring, and regulation of the 12MC impoundments. A fishery isolation barrier was proposed at the Highway 37 bridge to prohibit movement of migratory fish (e.g. hybrid bass) into the impacted areas of Lake Hartwell. Fishery isolation of these upstream areas, which represent less than 10% of the total area of Lake Hartwell, was expected to result in an accelerated decline in hybrid bass PCB concentrations for the remaining +90% of the reservoir. Migratory fish represent approximately 50% of the fish harvested by weight from Lake Hartwell. Reduction of fish PCB levels would allow for rescinding existing fish advisories in these areas, returning the majority of lake to the maximum beneficial uses for the reservoir.

However, moderate public opposition was expressed towards EPA's preferred alternative during the formal public meeting and in subsequent written comments received during the comment period. The public cited two general reasons behind their opposition: 1) very little confidence with EPA's ability to design, construct and maintain a safe fishery isolation barrier that would meet the established Performance Standards at the estimated cost; and 2) Institutional Controls provide the most reliable mechanism for reducing human exposures to PCB contaminated fish, so the incremental cost of the fish barrier is not warranted. EPA considered

the public comments received and dropped the fishery isolation barrier component from the Institutional Controls remedy in the June 1994 ROD.

IV. REMEDIAL ACTIONS

This section of the Five-Year Review Report provides a summary of the Remedial Actions performed since the June 1994 ROD. The following discussion is organized and presented by the four major components of the selected Monitored Natural Recovery/Institutional Controls remedy for Sangamo OU2

Continuation of the Fish Consumption Advisory

A fish consumption advisory, warning the public against eating fish from the Seneca River Arm of Lake Hartwell north of State Highway 24 and Twelve Mile Creek, was originally issued by SCDHEC in 1976. This advisory has been modified several times and remains in effect. Signs warning against eating fish have been posted at the majority of the public boat launch and recreation areas in South Carolina since 1987. The advisory was last modified in early 1998 when steps were taken to issue a joint advisory between Georgia and South Carolina. The current advisory adopts a risk-based approach that issues meal frequency advice to Lake Hartwell anglers based on species harvested and PCB concentration trends in fish tissue. The Lake Hartwell PCB fish advisory for South Carolina and Georgia is posted at www.scdhec.gov/eqc/admin/html/fishadv.html. The advisory is summarized in the table below.

Arm of Lake Hartwell	Kinds of Fish	Consumption Advice [1]
Seneca River Arm	ALL FISH	DO NOT EAT ANY
12 Mile Creek	ALL FISH	DO NOT EAT ANY
Remaining Waters of Lake Hartwell	Hybrid & Striped Bass	DO NOT EAT ANY
	Largemouth Bass Channel Catfish	1 meal/month

[1] - A meal is a half-pound (8 ounces) serving of fish

Public Education Program

The Public Education Program was initiated in July 1998 by the preparation of a color brochure designed to make users of Lake Hartwell aware of current fish consumption advisories and to assist them in making informed decisions regarding consumption of fish harvested from the Lake. Approximately 20,000 copies of this brochure were printed and distributed in July 1998 to an estimated 8,000 dock permit holders on Lake Hartwell, an estimated 1,400 members of the Lake Hartwell Association, approximately 100 retail outlets in six counties that border the Lake which sell fishing licenses, the Corps of Engineers Lake Hartwell Visitor Center, South

Carolina and Georgia Welcome Centers on Interstate I-85, Lake Hartwell campgrounds and day-use areas, local Chamber of Commerces', and miscellaneous personnel with involved State regulatory agencies

The success of this effort was measured by postage paid survey cards attached to the brochure. The Agency received replies to approximately 3-4% of the total volume distributed. The results of this effort are summarized in the table below and indicate a high success rate in effectively communicating the intended message. For example, 36% of respondents indicated that "most" of the information presented in the brochure was new, and an additional 58% indicated that "some" of the information was new. The replies to the remaining questions were also very encouraging, with favorable response rates in the 90th percentile range.

Results from Lake Hartwell Fish Consumption Advisory Survey Public Education Brochure, 1998 Fishing Season "Lake Hartwell Fish...Catching, Cleaning & Cooking"			
Survey Question	Most of it	Some of it	None
1. How much of the information in the brochure was new to you?	36%	58%	6%
	Yes		No
2. After reading this brochure, are you aware of the fish advisories for the waters of Lake Hartwell?	99.4%		0.6%
3. Do you understand the health risks of eating fish from the waters of Lake Hartwell?	96%		4%
4. Will you share this brochure with a friend or family member?	97%		3%
5. Do you now understand that you should not eat fish caught in the Twelve Mile Creek and Seneca River Arms of Lake Hartwell?	99%		1%
6. Do you understand how to trim fatty areas from the fish to reduce chemicals in the fish?	98%		2%
7. Did you have any problems understanding the information in this brochure?	8%		92%

The 1998 public education brochure was followed up with a telephone survey to provide a sense of the level of public awareness of fish advisories for Lake Hartwell, and how these advisories are affecting fish consumption of nearby residents. The telephone survey targeted nearby residents who might fish in Lake Hartwell, rather than known users of the lake.

Specifically, 100 residents from each of six counties (Anderson, Pickens, and Oconee in South Carolina, Hart, Franklin, and Stephens in Georgia) for a total of 600 respondents were interviewed from March 10-12, 2000. The general conclusions of this effort are summarized below

- Most respondents are aware of the fish advisories through a variety of sources;
- Respondents who indicated that they possessed a fishing license (39%) were more likely to be familiar with fish advisories, to have obtained a copy of the brochure that was distributed, and to report being influenced by its contents;
- Relatively few respondents (11%) consume Lake Hartwell fish; of those 11%, half eat lake fish less than once a month,
- Of those respondents who consume Lake Hartwell fish, 46% follow the fish advisories
- The majority of respondents who received a brochure read all or most of it, and
- An overwhelming majority of respondents who read the brochure said it helped them make an informed decision about catching and consuming fish from the lake.

In 1999, SCDHEC conducted a health consultation, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), to determine whether people consuming fish from Lake Hartwell are being exposed to elevated levels of PCBs. The target population were people who lived nearest 12 Mile Creek and the Seneca River Arm of Lake Hartwell. The health consultation was conducted in two phases.

Phase I included the distribution of a 1 page survey to screen for people who had eaten fish from the focused study area in the previous year. Approximately 11,000 surveys were distributed throughout Anderson, Pickens, and Oconee counties in South Carolina. Approximately 10,000 surveys were distributed to 22 public schools (K-12) and another 1,000 were distributed to local SCDHEC and SC Department of Natural Resource offices, Clemson University, bank fisherman, the Town Hall of Pendleton and upon request. There were 3,864 surveys returned for a response rate of 35%. For the survey respondents, 57% were aware of the Lake Hartwell fish consumption advisory, and 92% did not eat any fish in the past year. Only 310 (8%) stated they ate fish in the past year.

Phase II consisted of an exposure investigation in which 30 individuals who reported eating fish from Lake Hartwell in the past year participated in blood sampling. Serum PCB levels in the 30 participants ranged from less than the detection limit (3 µg/L) to 19.5 µg/L. Eighteen participants had non-detectable levels in their blood. Ten participants had levels between 3 and 10 µg/L. The mean level was 3.3 µg/L, using 1.5 µg/L as the default value for non-detects. The one individual who had the highest value reported (19.5 µg/L) had reportedly been occupationally exposed while working at the Sangamo plant impregnating capacitors with PCBs from 1965-1966.

SCDHEC and ATSDR concluded that serum PCB levels in the exposure investigation participants were very similar to those in previous studies of the general U.S. population, and less than expected for this group of fish consumers. The general U.S. population mean serum PCB

level ranges from 0.9 to 1.5 µg/L. Under ATSDRs public health hazard categories, the exposure pathway evaluated for this effort would be classified as no apparent public health hazard. The exposure from fish consumption appears to be minimal and health effects are unlikely for people that eat small to moderate amounts of fish. However, there are inherent uncertainties associated with investigations of this nature (e.g. small number of participants in blood sampling/best sample population not recruited for this health consultation).

Aquatic Biota and Sediment Monitoring

Annual monitoring of sediments and aquatic biota has been conducted by Schlumberger, pursuant to EPA approved work plans, in the Spring of each year since the ROD was issued in June 1994. This effort includes: 1) sediment sampling at twenty-one locations in 12MC, the 12MC Creek Arm of Lake Hartwell, and portions of Lake Hartwell proper; 2) fish tissue analyses at six stations in Lake Hartwell for largemouth bass, catfish, and hybrid bass; 3) fish tissue analyses on forage fish species at three locations in Lake Hartwell, and 4) 28-day caged *corbicula* analyses at seven stations in 12MC.

Additionally, EPA's National Risk Management Research Laboratory (NRMRL) and National Exposure Research Laboratory (NERL) conducted three phases of research on Lake Hartwell to gain a better understanding of natural mechanisms that contribute to the recovery of PCB contaminated sediments. Moreover, the goal of these investigations was to develop and evaluate physical, chemical, and biological tools and approaches for measuring the short and long-term performance of MNR remedies. The scope of the three phases of investigation are briefly summarized below.

Phase 1 (EPA/Battelle report dated September 25, 2001)

- Collection of 10 sediment cores at transects that coincide with ROD annual monitoring stations and sediment modeling efforts;
- Age dated sediment cores using Lead-210 and Cesium-137 techniques to determine sediment accumulation rates (cm/yr) and sedimentation rates (g/cm²-yr),
- Detailed PCB congener analyses to identify vertical/lateral congener profiles and trends;
- An evaluation of PCB compositional changes (e.g. level of chlorination) in historically deposited sediments; and
- A comparison of age dating results with sediment deposition rates predicted by the modeling effort.

Phase 2 (EPA/Battelle report dated June 30, 2002)

- Collection of 8 sediment cores at three transects previously studied in Phase 1;
- Collection of 21 surface sediment and nine high volume surface water samples within the 12MC watershed and near the former Sangamo plant site;
- Sediment age dating using Lead-210 and Cesium-137 techniques; and
- PCB congener analysis to identify historical PCB depositional patterns, PCB weathering patterns (e.g. dechlorination), and PCB end member analysis (e.g. fingerprint patterns).

Phase 3 (Draft EPA/Battelle report dated April 2003)

- Development of a fully integrated ecological model to assess the ongoing impact of PCB contaminated sediments on the benthic and aquatic environments,
- Tests were conducted at three stations, two within the 12MC Arm of Lake Hartwell, and one background station,
- PCB surface sediment and surface water sampling/analysis,
- Biota collection/analysis which included native fish collection, Hester Dendy trap deployment for macroinvertebrate sampling, Fat Head Minnow (FHM) cage deployment, *corbicula* cage deployment, and phytoplankton collection;
- Deployment of semi-permeable membrane devices (SPMD) to simulate uptake by fish lipids,
- Volatilization studies to measure diffusion from the lake surface,
- Deployment of PCB gas flux chambers to measure gas evolution from the sediment surface, and
- Evaluation of advective transport of the water through the sediments using a network of piezometer wells

The results of 9 years of annual monitoring and 3 phases of EPA-NRMRL/NERL investigations are too voluminous to present in detail in this Five-Year Review Report. The reader is referred to the reports listed above and in Section VI of this Five-Year Review Report for a more detailed account of the findings and conclusions. The following text provides a brief overview of the results

In general, PCB sediment concentrations have decreased steadily as the deeper, more impacted sediments are covered by physical sedimentation processes typical of man-made, fresh-water reservoir ecosystems. Recent surficial sediment data in the 12MC Arm of Lake Hartwell indicate an approximate 10 to 50 fold reduction in PCB concentrations when compared to historical data. PCB concentrations in surficial sediments of the 12MC Arm of Lake Hartwell were reported in the 1 to 5 mg/kg range during the most recent sampling events. Surficial sediments in the upper 12MC Arm of Lake Hartwell (e.g. portions impacted by previous hydraulic dredging and flushing events) have PCB concentrations generally below the 1 mg/kg cleanup goal selected in the ROD. Sediment age dating results and statistical analysis using the 95% confidence interval were used to predict the sedimentation and time required to achieve the 1 mg/kg cleanup goal. This analysis predicts that the majority of the surficial sediments in the 12MC Arm of Lake Hartwell will achieve the 1 mg/kg cleanup goal between 2007 and 2011.

However, annual monitoring results for largemouth bass, channel catfish, and hybrid bass indicate PCB tissue concentrations have not responded measurably to the decreased surface sediment trends. Despite the consistent data set, PCB trend analysis in fish tissue has proven to be a difficult task given the many variables involved (e.g. gender, lipid content, age/size of fish caught, number of fish caught per station, dietary considerations, migratory behavior, etc.) PCB concentrations in largemouth bass in the 12MC and Seneca River Arms of Lake Hartwell continue to be above the 2.0 mg/kg FDA limit, although channel catfish from these stations

dropped below 2.0 mg/kg limit in 1999 and have remained below that level. PCB concentrations in hybrid bass remain greater than 2.0 mg/kg at all six stations in Lake Hartwell.

Consistent with the results of the RI/FS, the Phase 3 EPA-NRMRL/NERL report documented the presence of PCBs in all media evaluated for the two stations within the 12MC Arm of Lake Hartwell. At the risk of oversimplification, it appears that diffusion/advection from surficial sediments to the pore water and surface water is playing an important role in PCB transfer to upper trophic level receptors. For example, *corbicula* baskets deployed for 28 days near the former Sangamo plant discharge point in Town Creek and within the 12MC watershed are accumulating PCBs in the 1 to 2 mg/kg range. Co-located sediment samples and high volume surface water samples are generally reporting detectable concentrations of PCBs in the parts per billion and parts per trillion range, respectively.

Pursuant to these findings, EPA-NRMRL/NERL suggested that PCB contribution from the former Sangamo plant site may be continuing source of PCB loading to Town Creek. Review of groundwater recovery system capture zones, the resultant potentiometric surface of the groundwater table, and monitoring well data from the former Sangamo plant wastewater treatment lagoons indicate a potential for a groundwater to surface water transport pathway. As a result, the 2004 annual monitoring program was modified to include placement of *corbicula* baskets at regular intervals along the suspect reach of Town Creek. The goal of this continuing source investigation is to identify sub-reaches of Town Creek that may be contributing PCBs to the system. Future investigative work, such as geoprobe installation and tweaks to the groundwater recovery system, will be evaluated after review of the 2004 annual monitoring results.

It is also possible that 12MC continues to export low levels of PCBs into Lake Hartwell that may delay recovery in the 12MC Arm of Lake Hartwell. Potential vehicles for PCB export from 12MC include contaminated sediments, organic carbon, and organisms such as fish. EPA-NRMRL/NERL is also conducting a 2 year survey (e.g. 2003-2004) of PCB levels in resident biota in Town Creek and 12MC. This study is designed to determine the extent and distribution of residual contamination within the 12MC ecosystem and to determine potential pathways of PCB biomagnification through the stream's food web.

Finally, EPA-NRMRL/NERL recommended some modifications to the annual aquatic biota and sediment monitoring program that is conducted by Schlumberger. These modifications reflect the advances in the technical community's understanding of PCB science since the annual monitoring program was first formulated in 1994. The modifications generally include adding congener specific analysis for fish, *corbicula*, and sediment at select stations, adding more replicates for forage fish species to increase the strength of statistical evaluations, adding lipid analysis for *corbicula* samples, and reducing gender bias in game fish samples.

Twelve Mile Creek Impoundments

Of the four remedy components specified in the June 1994 ROD, ensuring regular, downstream passage of sediments trapped behind the 3 impoundments on 12 Mile Creek has proven to be the most challenging for EPA. The primary goal of EPA's Sangamo OU2 remedy is to use the natural sedimentation processes of 12MC to deliver sediment to the 12MC Arm of Lake Hartwell, thus providing a clean sediment cap on top of PCB impacted sediments to prevent further resuspension and transport of sediments throughout the creek and lake ecosystem.

A significant quantity of the sediment bed load transported via the upper reach of Twelve Mile Creek is trapped behind three impoundments. The first, or uppermost dam, is owned by the Easley-Central (E-C) Water District which uses the head pool for raw water storage. The E-C dam is equipped with high flow sluice gates which provides E-C control with regard to when they flush sediments, and how much material they flush per event. E-C sluices sediments approximately quarterly, and their flushing schedule generally meets the requirements specified in the ROD.

The second and third dams on 12MC are Woodside 1 (WS1) and Woodside 2 (WS2), respectively. WS1 and WS2 are small hydroelectric impoundments that are currently owned and operated by Consolidated Hydro Southeast. WS1 and WS2 are reported to produce a combined electrical output of 2.5 million kWh/year, and both dams are equipped with low flow sluice gates. Historically, sediment was flushed downstream via sluice gates when sediment accumulations began to interfere with power generation. Sediment flushing events during low flow periods in 1984 and 1993 were documented to have adverse impacts on water quality, stream habitat, and in some instances resulted in fish kills.

In response to the September 1993 flushing event, SCDHEC entered into a Consent Order with the owners of WS1/WS2 (e.g. Consolidated Hydro) in June 1994 to develop a more effective sediment management plan. Further discussions between SCDHEC, EPA, Consolidated Hydro and Schlumberger produced the following agreements which were mutually acceptable to all stakeholders. 1) Consolidated Hydro would no longer flush sediment downstream through the WS1/WS2 sluice gates; and 2) Consolidated Hydro would install automated trash rack rakes immediately in front of the respective intake structures to suspend accumulations of sand/sediment that would subsequently be passed downstream through the turbines. In September 1997, Consolidated Hydro informed all involved entities that while the rakes were performing as expected, the quantity of sediment accumulation was greater than can be passed through the turbines without causing severe damage to the turbine shafts and bearings due to excessive abrasive action.

In March 1998, Schlumberger completed an analysis of feasible sediment management alternatives to fulfill the requirements of the ROD. This feasibility study evaluated a number of alternatives that included installation of new high flow sluice gates, complete purchase and removal of the impoundments by Schlumberger, and a dredging alternative that would pump

sediments over the respective impoundments. When considering the evaluation criteria of technical feasibility, cost effectiveness, non-interference with the power operations, and overall protection of human health and the environment, the dredging and pumping alternative rated the most favorably.

In October 1998, dredging was first initiated at the WS1 and WS2 impoundments via a Nationwide Permit No. 38 from the U.S. Army Corps of Engineers. A portable cutterhead dredge, suction pump, and flexible 8-inch discharge line was used to pass material from the respective head pools to the downstream tail race. In theory, all dredged material pumped over the dams would be ultimately transported to the Upper 12MC Arm of Lake Hartwell by utilizing the natural bed load carrying capacity of 12MC. Based on the specifications of the dredge equipment, and an assumption that the head pools would be ultimately maintained at a 15-20 foot depth for 300 yards upstream, it was estimated that the cutter-head dredge would operate 10 hrs/day for 35 days/year at each location. An estimated 7,000 cubic yards (CY) was pumped downstream of WS1 and WS2 during the October 1998 dredging event. During this time, residents that lived in close proximity to the dredging operations first began to express concerns about localized accumulations of sediment near Lay Bridge (e.g. downstream of WS2) and associated impacts to benthic communities and aquatic plants.

A second dredging event was conducted in July 1999 when an estimated 10,000 CY of sediment was dredged and passed downstream of the WS1 and WS2 impoundments. The summer months in upstate South Carolina are typically low flow periods, and residents along the 12MC corridor and in the nearby village of Catechee again expressed their concerns regarding negative impacts to the creek caused by localized accumulations of sediment. In response to these concerns, biologists from both EPA and SCDHEC conducted pre- and post-dredging aquatic macroinvertebrate assessments on 12MC in an attempt to quantify damages caused by the hydraulic dredging events. Both technical reports (e.g. see references under Section VI.) generally concluded that hydraulic dredging events had caused short-term impacts to stream habitat and benthic communities, but stream conditions improved to background conditions once a sufficient storm event occurred to move localized sediment accumulations further downstream into the headwaters of Lake Hartwell.

In September 1999, a meeting was held at SCDHEC's offices in Columbia, SC with involved stakeholders to develop a mutually acceptable path forward regarding a sediment management plan for the WS1/WS2 impoundments. At this meeting, EPA agreed to limit hydraulic dredging to the typically high flow months of December through February. This time frame also avoids creating a turbidity issue in 12MC during fish spawning periods in the spring and early summer. EPA also committed to conducting sediment transport modeling and to evaluating additional sediment management alternatives. Field data to support sediment transport modeling was conducted in December 1999. Sediment transport modeling was conducted to predict the fate of sediments flushed and dredged from the WS1/WS2 dams from April 1992 to September 1999. Additional sediment management alternatives evaluated included extending the hydraulic dredge pipeline 5 miles to the headwaters of Lake Hartwell (e.g. Maw

Bridge), and Hydrosuction Sediment Removal Systems (HSRS). An HSRS is a pipeline system capable of transporting a water/sediment slurry past a dam using the natural energy represented by the difference in water surface elevations between the upstream and downstream sides of a dam. Results of the sediment transport modeling and the second iteration of sediment management alternatives are presented in April 25, 2000 technical report prepared by the U.S. Army Corps of Engineers, Engineer Research and Development Center, Waterways Experiment Station.

Pursuant to the conclusions of the April 25, 2000 report, EPA proposed installing high flow sluice gates on the back side of the WS1/WS2 impoundments, similar to those of the E-C Water District impoundment. A high flow sluice gate evaluation conducted by RMT, on behalf of Schlumberger, estimated the cost of installation at \$610,000 total (e.g. approximately \$300,000/dam). In June 2000, EPA notified the Natural Resource Trustees (NRTs) and other involved stakeholders of plans to direct Schlumberger to install high flow sluice gates on WS1 and WS2 pursuant to the ROD and effective UAO. By this time the NRTs had initiated a Natural Resource Damage Assessment (NRDA) process that included a component for 12MC dam removal and subsequent stream corridor restoration. The NRTs asked EPA to postpone capital improvements to WS1/WS2, and EPA agreed to monitor progress of the NRDA settlement negotiations.

Hydraulic dredging of sediment from the head pools of WS1/WS2 was conducted again in January 2001 and February 2002. Hydro-power generation at WS1 ceased in July 2003, and at WS2 in September 2003 due to excessive accumulation of sediment in the head pools. Data collection and sediment modeling performed in November 2002 to support dam removal evaluations indicate there is approximately 300,000 CY of sediment currently entrained behind the three 12MC impoundments. A technical agreement in principle has been reached between the NRTs and Schlumberger regarding a NRDA settlement that would, among other items, involve removal of the WS1 and WS2 dams. In August 2004, the NRTs and Schlumberger met with property owners along the approximate 10,000 foot reach of 12MC that is proposed for restoration to discuss access arrangements. The NRTs and Schlumberger are expecting to release the formal Lake Hartwell Restoration and Compensation Determination Plan during the 4th quarter of 2004.

EPA fully supports the dam removal concepts envisioned in the NRDA settlement as it represents the most permanent solution to ensuring natural sediment transport downstream to the 12MC Arm of Lake Hartwell. EPA continues to monitor the progress of the NRDA settlement, and if an agreement is reached, EPA plans to issue an Explanation of Significant Difference (ESD) to the ROD that would allow dam removal and stream corridor restoration to move forward. If removal of WS1 and WS2 is not included in the NRDA settlement for whatever reason(s), EPA will direct Schlumberger to install high flow sluice gates.

V. PROGRESS SINCE THE LAST REVIEW

This was the first Five-Year Review for the site.

VI. FIVE-YEAR REVIEW PROCESS

The Five-Year Review effort for Sangamo OU2 primarily consisted of review of technical documents that were generated to facilitate the remedy effectiveness evaluation. The documents listed below were reviewed to support preparation of this Five-Year Review and are attached to this report as references.

- Final Record of Decision for the Sangamo Weston/Twelvemile Creek/Lake Hartwell PCB Contamination Superfund Site, Pickens County, SC (US EPA - Region 4, June 28, 1994),
- Lake Hartwell Fish and Sediment Study Operable Unit Two Monitoring Program (ERM-Southeast) Annual reports are available for 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, and 2003,
- Lake Hartwell Fish . .Catching, Cleaning & Cooking (Public Education Brochure, EPA-Region 4, 1998 Fishing Season);
- Unilateral Administrative Order for Operable Unit Two, Sangamo Weston/Twelvemile Creek, Lake Hartwell PCB Contamination Superfund Site (US EPA Region 4, September 1998)
- Final Report Twelvemile Creek Data Collection, Sangamo Weston Operable Unit Two, Pickens County, SC (RMT, December 1999);
- A Macroinvertebrate Biological Assessment of a Sediment Release in Twelvemile Creek Below a Small Reservoir in Pickens County, SC (SCDHEC Bureau of Water, Technical Report 013-00, January 2000),
- Sluice Gate Installation Evaluation for Woodside I & II, Sangamo OU2 (RMT, January 27, 2000),
- Telephone Interviews of Residents in the Lake Hartwell Area (Decision Quest, Inc., March 2000);
- Biological Monitoring of Dredging Activities in Twelvemile Creek (EPA SESD Project No 99-0436, April 20, 2000),
- Sediment Transport Studies on Twelvemile Creek and Lake Hartwell in Support of the EPA Selected Remedy (ERDC, Waterways Experiment Station, U.S Army COE, April 25, 2000)
- Natural Recovery of Persistent Organics in Contaminated Sediments at the Sangamo Weston/Twelvemile Creek/Lake Hartwell Superfund Site - Phase I (Prepared by Battelle on behalf of EPA-National Risk Management Research Laboratory, September 25, 2001),
- Natural Recovery of Persistent Organics in Contaminated Sediments at the Sangamo Weston/Twelvemile Creek/Lake Hartwell Superfund Site - Phase II (Prepared by Battelle on behalf of EPA-NRMRL, June 30, 2002),
- Twelvemile Creek Sediment Transport Model/Data Collection Report, Sangamo OU2 (RMT, November 2002);
- Impact of In-Stream Dam Removal on the Morphology of Twelvemile Creek, (ERDC,

- Waterways Experiment Station, U S Army COE, February 2003),
- *Draft Natural Recovery of Persistent Organics in Contaminated Sediments at the Sangamo Weston/Twelvemile Creek/Lake Hartwell Superfund Site - Phase III* (Prepared by Battelle on behalf of EPA-NRMRL, April 2003);
- *Long-Term Recovery of PCB-Contaminated Surface Sediments at the Sangamo Weston/Twelvemile Creek/Lake Hartwell Superfund Site*, Brenner et. al (Environmental Science and Technology, Volume 38, No. 8, 2328-2337, 2004); and
- *Health Consultation, Lake Hartwell Fish Consumption PCB Contamination, Sangamo Weston/Twelvemile Creek/Lake Hartwell* (U S Department of Health and Human Services, ATSDR, July 26, 2004).

VII. TECHNICAL ASSESSMENT

As recommended by EPA's Comprehensive Five-Year Review Guidance (OSWER No. 9355.7-03B-P, June 2001), the framework for the technical assessment of the Interim Remedial Action centers around answering the following three key questions.

- *Question A Is the remedy functioning as intended by the decision documents?*

Yes

- *Question B Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives (RAOs) used at the time of remedy selection still valid?*

Not completely. The FGETS bioaccumulation model predicted fish tissue concentrations in the 12MC Arm of Lake Hartwell would decline in response to decreasing water column and surface sediment PCB concentrations. FGETS predicted largemouth bass concentrations in the 12MC Arm of Lake Hartwell would fall below the 2 mg/kg FDA level in the 2003 to 2005 time frame. Largemouth bass fillets from the 12MC embayment remain in the 2-4 mg/kg range, although channel catfish fell below the 2 mg/kg level in 1999 and have remained below that level since.

- *Question C Has any other information come to light that could call into question the protectiveness of the remedy?*

Under Evaluation Information gathered during the Five-Year Review process indicated the potential for a continuing groundwater to surface water transport pathway from the former wastewater treatment lagoons on the former Sangamo plant to Town Creek. Investigations are underway to fully evaluate this conceptual site model.

VIII. ISSUES

None

IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based on the above discussion and findings, the following recommendations are issued for this Five-Year Review:

- 1) SCDHEC to continue to administer the existing fish consumption advisory, and implement modifications as warranted by the annual aquatic biota and sediment monitoring program. New or updated fish advisory signs should be installed as necessary
- 2) Continue the annual aquatic biota and sediment monitoring program specified by the 1994 ROD. Modifications to annual monitoring program as recommended by EPA-NRMRL/NERL were implemented during the 2004 sampling event. The utility of this additional data will be evaluated upon receipt of the 2004 data, and decisions will be made at that time regarding the scope of future monitoring events.
- 3) Support the on-going NRDA settlement process regarding dam demolition and 12MC stream corridor restoration as requested by the Department of Justice (DOJ) and the NRTs. Issue an ESD at the appropriate time to allow dam removal to proceed forward
- 4) Initial investigations into the potential groundwater to surface water pathway at the Sangamo plant site and Town Creek discharge point were conducted in the Spring of 2004. Data for these initial investigations will be evaluated, and follow-up investigations will be implemented as appropriate

X. PROTECTIVENESS STATEMENT

The MNR/Institutional Controls remedy for OU2 is considered adequately protective of human health and the environment while long-term monitoring of aquatic biota and sediments continue in the future. Soil cleanup at OU1 is completed, and active groundwater recovery and treatment continues at the Breazeale site and the Plant site. Since operation and maintenance of these systems will be optimized to meet established performance standards, this site is considered adequately protective of human health and the environment.

XI. NEXT REVIEW

Pursuant to statutory requirements, the next Five-Year Review for this site will be conducted five years from the approval date of this document.